Landsat-5 TM and Landsat-7 ETM+ Performance Update

LDCM Science Team Meeting
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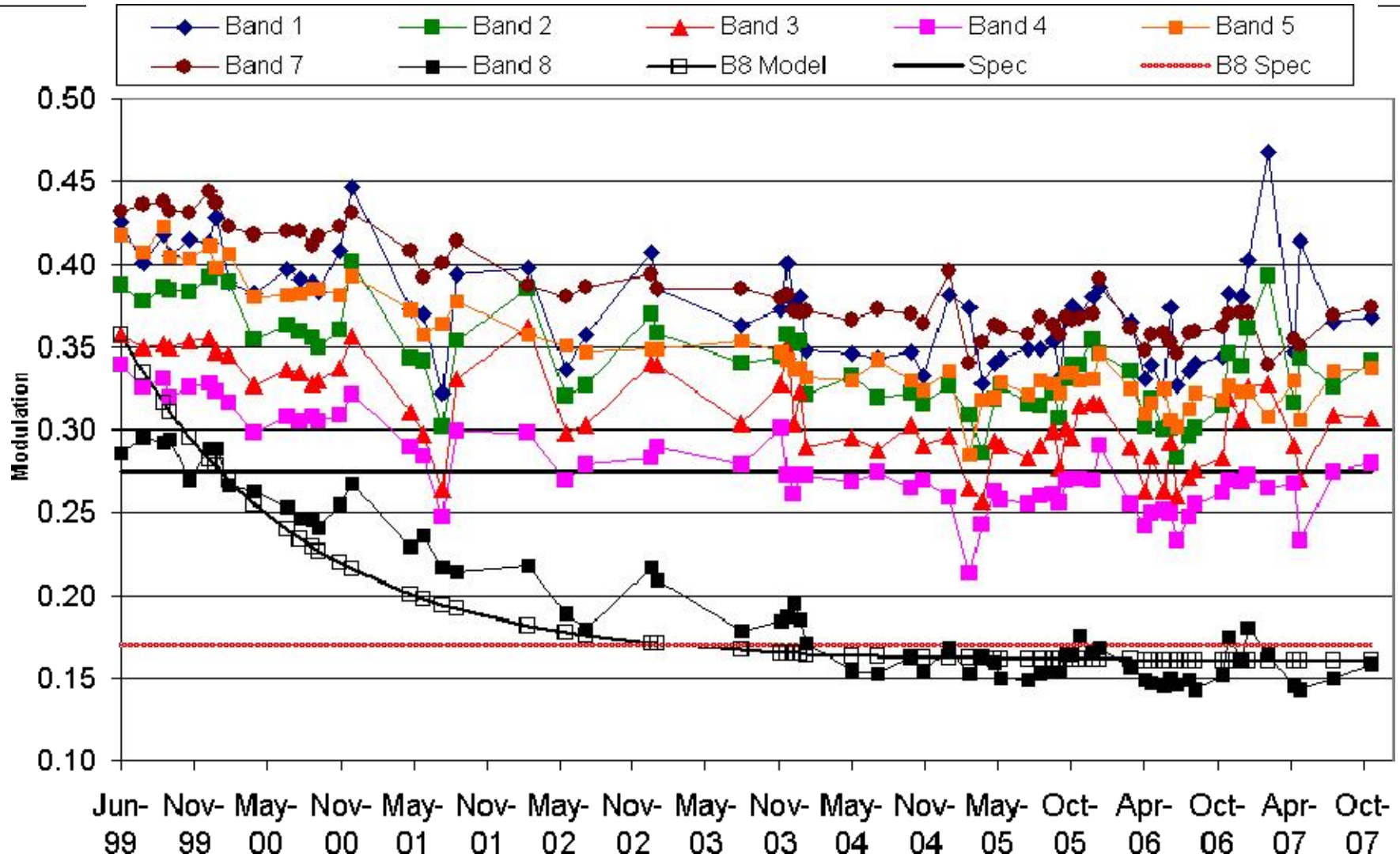
Landsat-7 ETM+ Geometric and Spatial Update

- Band-to-Band registration typically 0.05 pixels or better in line and scan direction (excluding band 6)
- MTF has stabilized in all bands model
  - band 4 slightly below specification of 0.275
  - Band 8 behavior consistent with pre-launch predictions
- Switch to bumper mode disrupted ETM+ sensor alignment calibration
  - Degraded geodetic accuracy since April 1, 2007
    - Pre-switch : 97% scenes better than 50 meters RMSE
    - Post-switch: 65% scenes better than 50 meters RMSE

Along-Scan MTF vs. Date



ETM+ Bumper Mode Performance

- Bumper parameter trends have stabilized following a brief adjustment period in early April
- ETM+ bumper mode performance is monitored in the same way as L5 TM performance
  - Analysis performed using daily calibration parameters
- Within-scan accuracy statistics for ETM+ SAM mode, L5 TM bumper mode, and ETM+ bumper mode:

	FWD Line RMSE	FWD Samp RMSE	REV Line RMSE	REV Samp RMSE
ETM+ SAM Mode	4.3 m	4.0 m	4.0 m	3.9 m
L5 TM Predicted	5.4 m	7.6 m	5.4 m	7.0 m
ETM+ Predicted	5.3 m	6.5 m	5.3 m	6.4 m
L5 TM Refined	5.4 m	5.6 m	5.4 m	6.2 m
ETM+ Refined	5.3 m	5.5 m	5.3 m	5.4 m

Landsat-5 TM Geometry Update

- Landsat-5 TM operating in bumper mode since 2002
  - Generate both monthly (heritage) and daily bumper mode parameter sets for L5
- Bumper mode calibration will likely require immediate update and (initially) frequent refinement if / when Landsat 5 resumes imaging operations

Bumper Mode Performance Summary

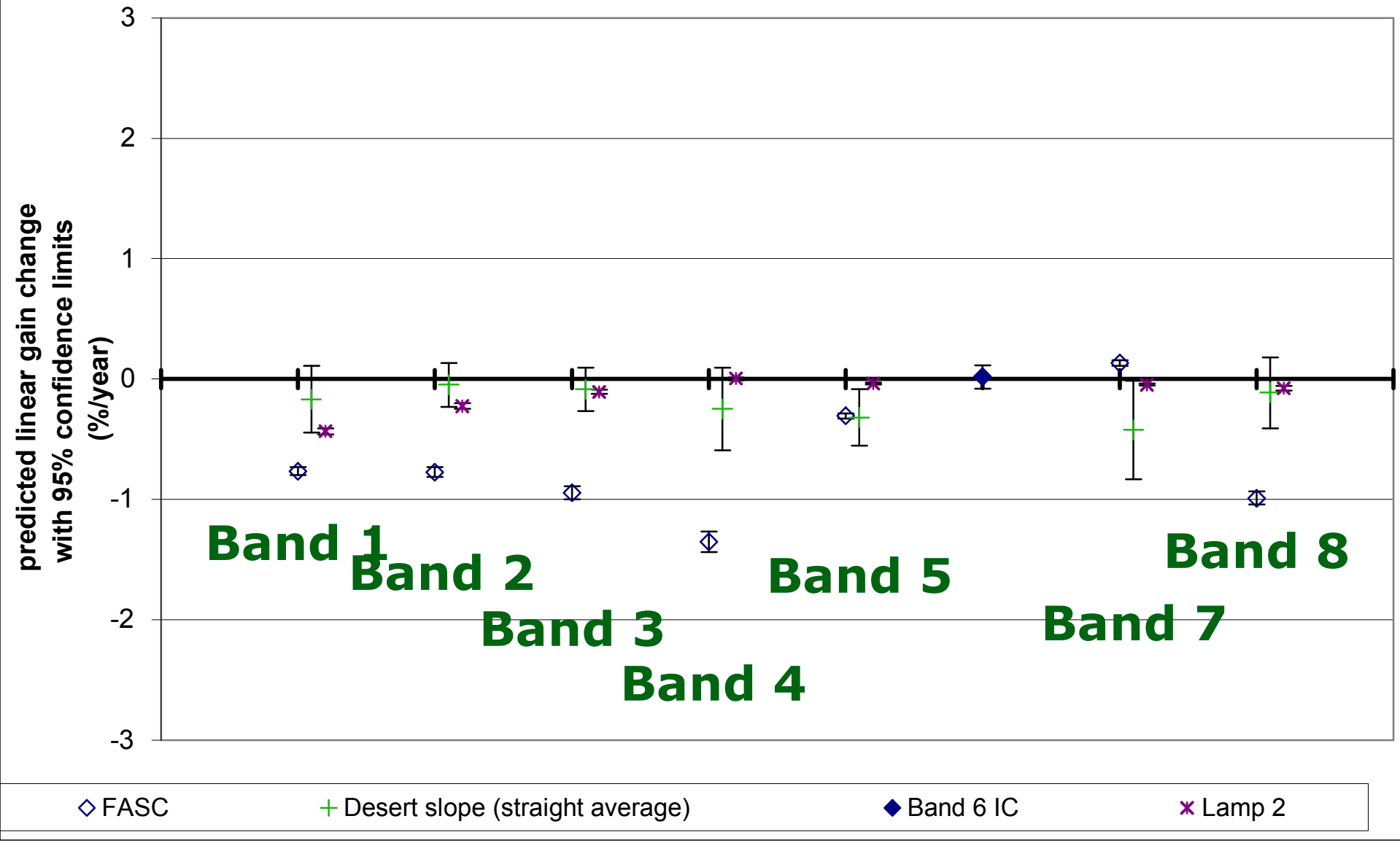
- Summary within-scan accuracy statistics are presented below for both the predicted and refined calibration parameters
  - Lifetime and recent statistics are shown
- ETM+ SAM mode values are shown for comparison

	FWD Line RMSE	FWD Samp RMSE	REV Line RMSE	REV Samp RMSE
ETM+ SAM Mode	4.3 m	4.0 m	4.0 m	3.9 m
TM Bumper Mode (Predicted) Life	5.5 m	7.9 m	5.6 m	7.9 m
Since 01APR2007	5.4 m	7.6 m	5.4 m	7.0 m
TM Bumper Mode (Refined) Life	5.5 m	6.4 m	5.6 m	6.7 m
Since 01APR2007	5.4 m	5.6 m	5.4 m	6.2 m

Landsat-7 ETM+ Reflective Band Radiometry Update

- Relative detector-to-detector normalization, i.e., striping less than ± 0.1%
- Between-date detector gain stable to < 0.5%/year
  - Based on desert sites--generally not statistically significant
- Absolute radiometric accuracy better than ± 5%
- Noise stable over mission life
  - Small improvement with SLC-off
  - Anomalous coherent noise gone with SLC-off
- SLC failure had no significant impact on L7 ETM+ reflective band radiometry- continues to be excellent

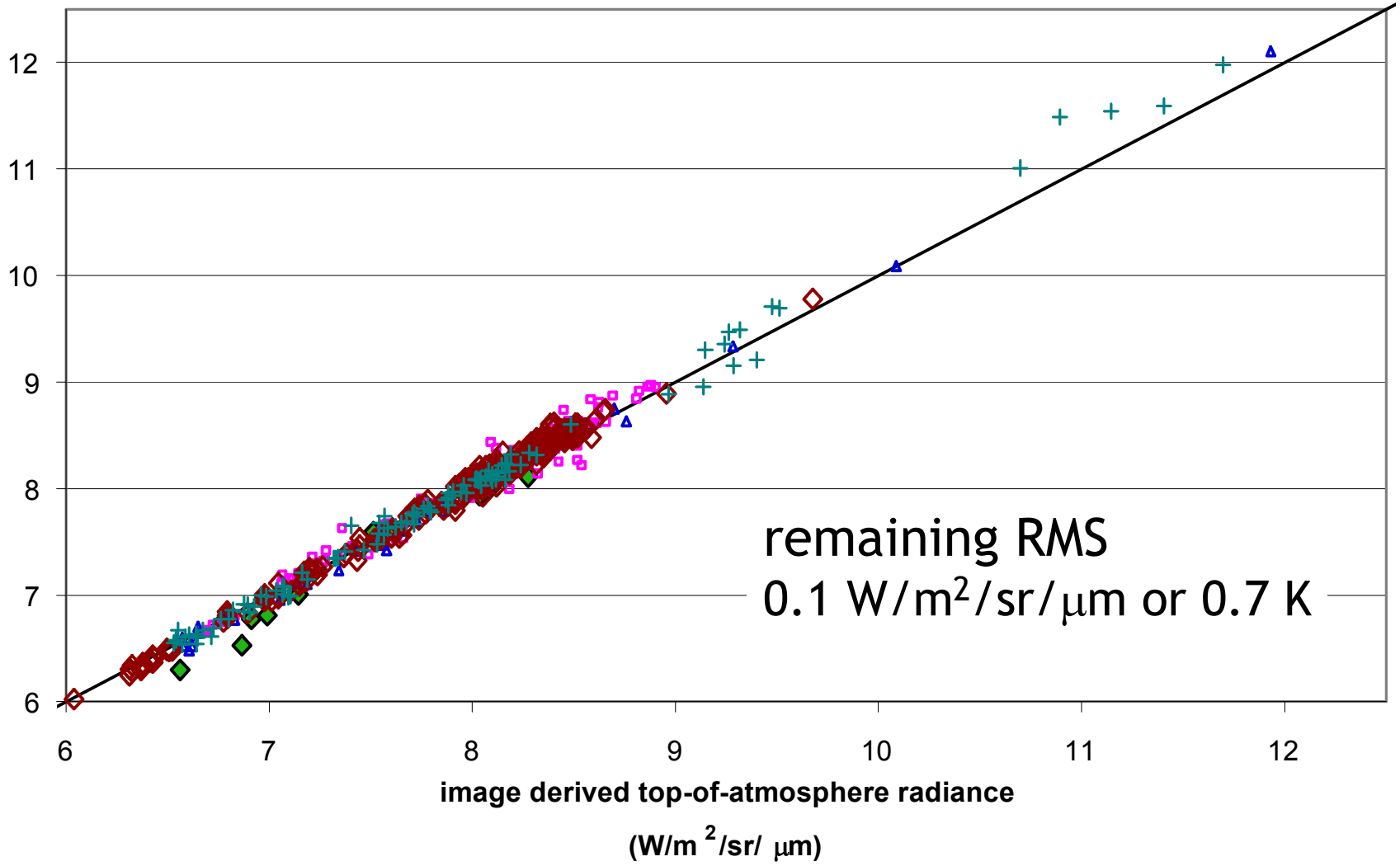
Gain Stability by Band



Landsat-7 ETM+ Thermal Band Radiometry Update

- Relative detector-to-detector normalization, i.e., striping less than ± 0.1%
- No observable change in instrument responsivity
- Absolute radiometric accuracy better than 1K
- Noise stable over mission life
- Switch to bumper mode resulted in change in shutter bias extraction regions
  - Incorrect shutter region windows as well as pulse losses resulted in severe banding (low gain) and striping (high gain) in data acquired and processed between April 1 and July1 and October 1 and October 28

Ground-Based Absolute Calibrati



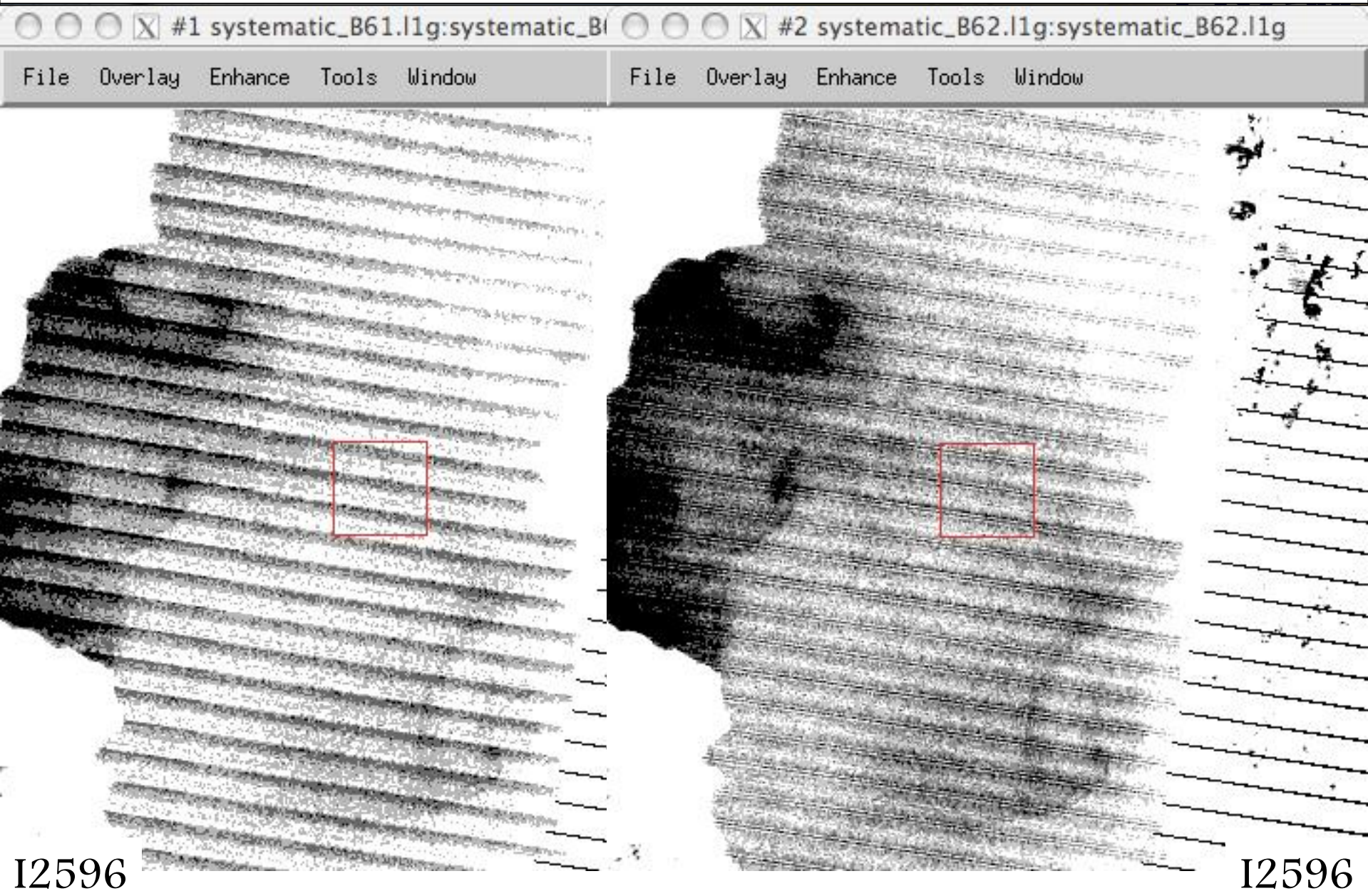
BLUE/GREEN: JPL data

PINK/BROWN: RIT data

"reanalysis data" incorporated

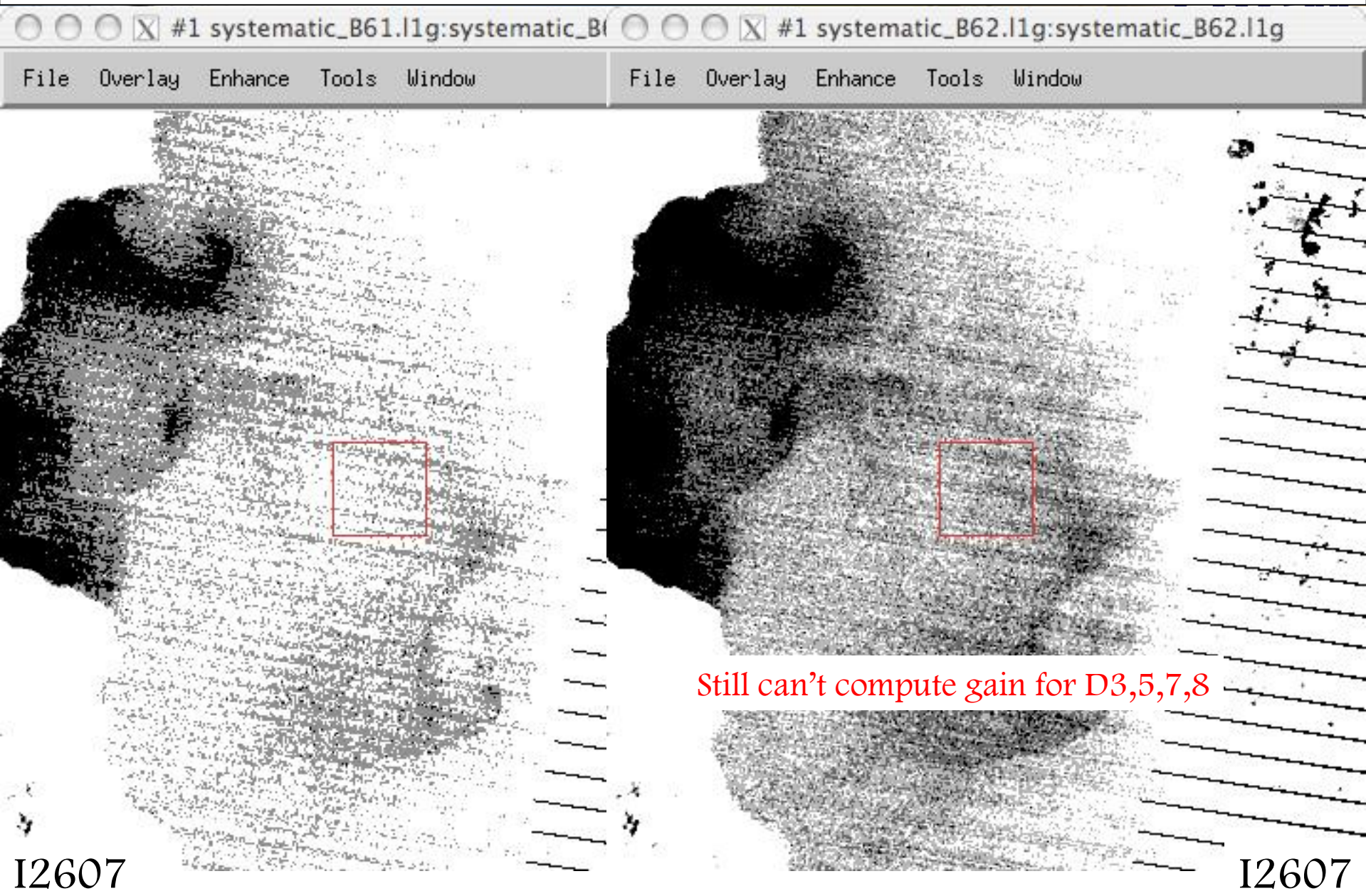
B61 ~ processed with Oct 1 CPF

B62 ~ processed with Oct 1 CPF



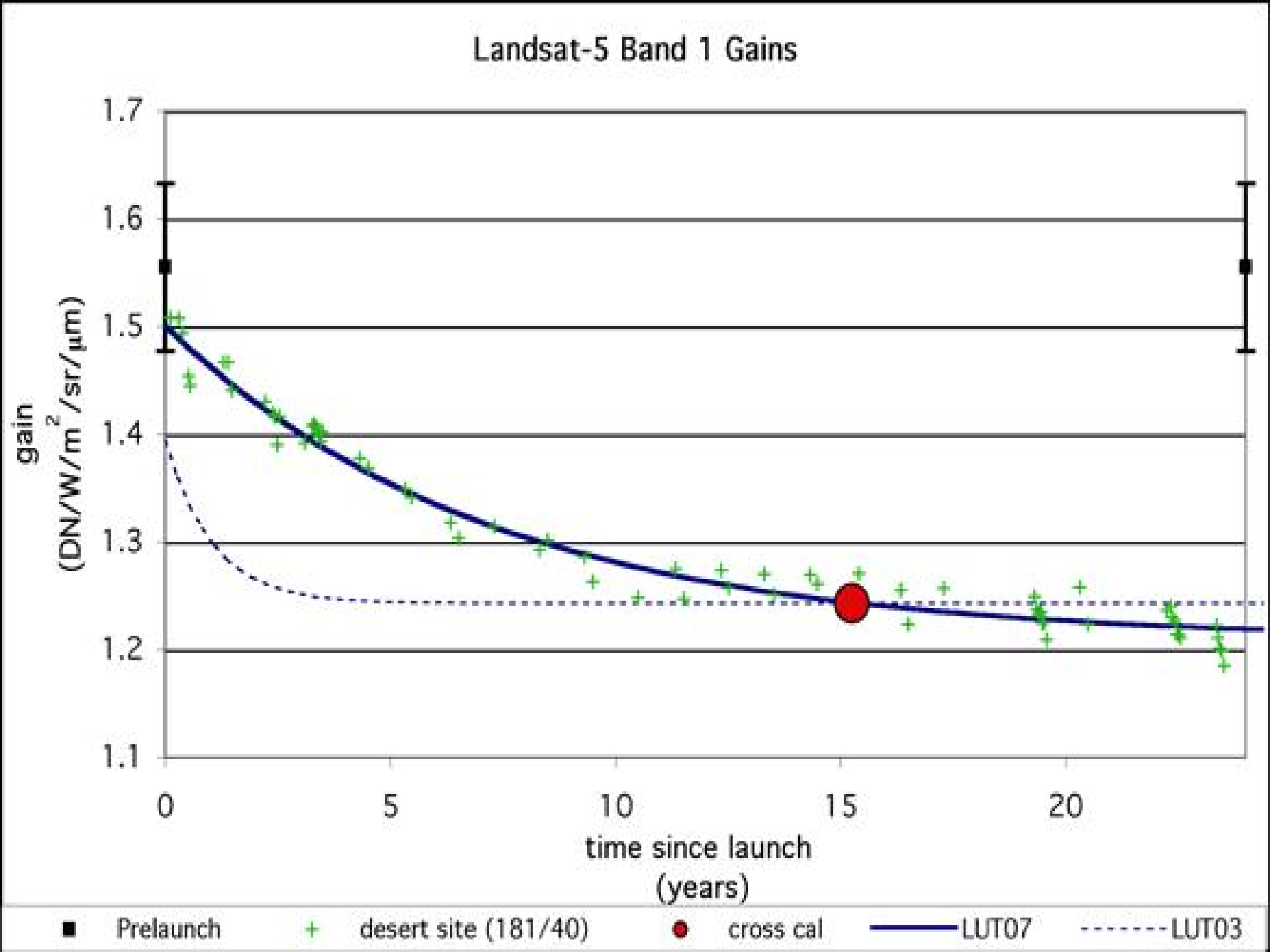
B61 ~ processed with modified CPF, new bias_locations and ACCA biases

B62 ~ processed with modified CPF, new bias_locations and ACCA biases



Landsat-5 TM Reflective Band Radiometry Update

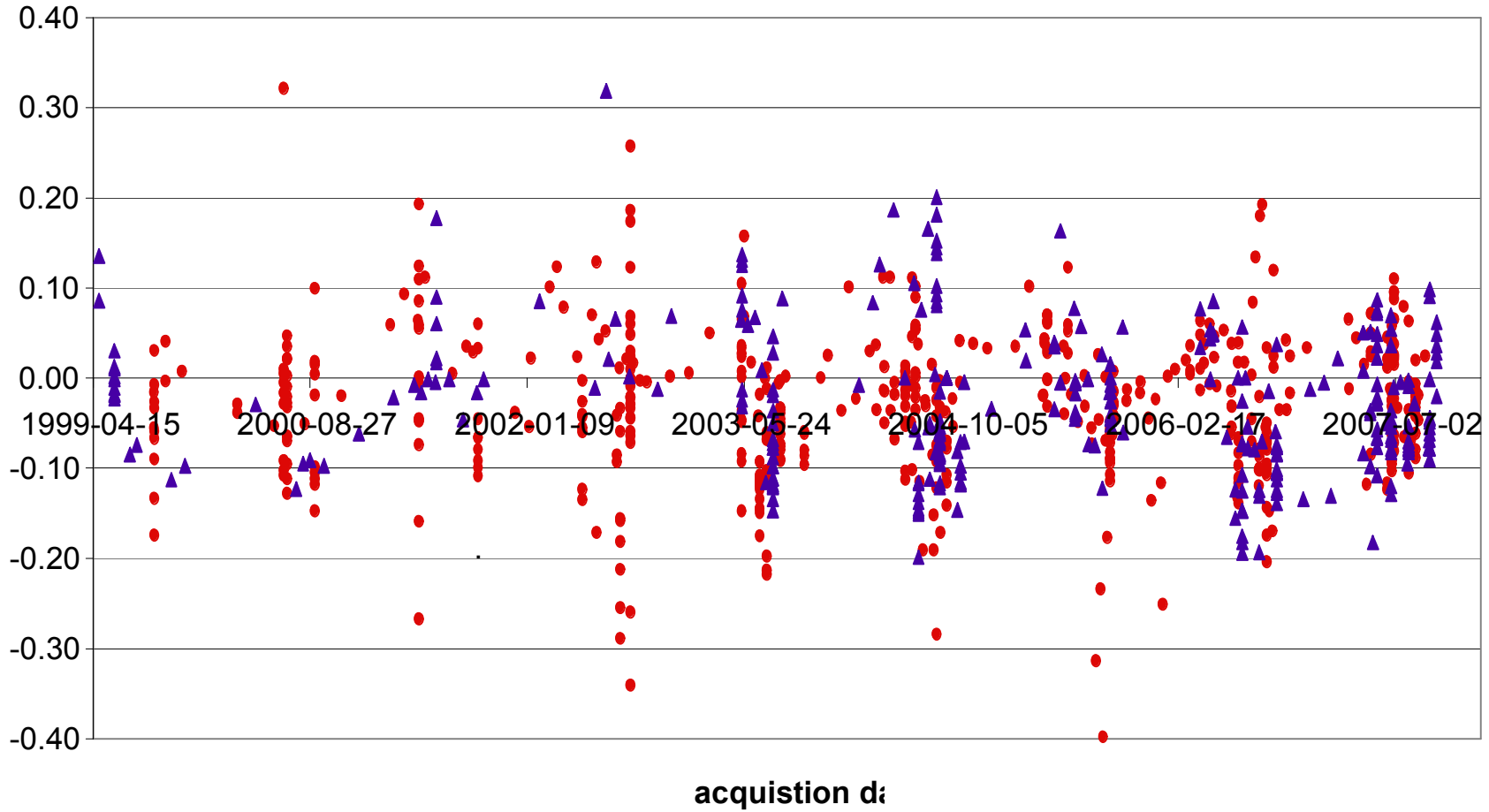
- Within-band within-scene internal stability
  - Scan-Correlated Shift (SCS) of up to 0.7 DN
    - Correctable with scan line-by-scan line background subtraction
  - Memory Effect of up to 4 DN
    - Currently corrected in NLAPS processing
  - Some banding and striping issues remain to be resolved
- Between-date stability
  - Interference cycling from icing on B5 and B7
    - Correctable with IC processing or LUT that includes interference cycling
- Radiometric calibration processing
  - Uses Gain Calibration History stored in Look-Up Table
  - Extracts and applies biases on a scan line by scan line basis
  - Rescaled to Fixed Radiance Range (LMIN, LMAX)
  - Look-up Table revised April 2, 2007 to reflect revised trends from Sahara desert site data obtained from ESA


Landsat-5 Band 1 Gains
1.7
1.6
1.5
1.4
1.3
1.2
1.1
gain
(DN/W/m 2 /sr/µm)
0
5
10
15
20
time since launch
(years)
Prelaunch
desert site (181/40)
cross cal
LUT07
LUT03

Landsat-5 TM Thermal Band Radiometric Calibration Update

- Sensitivity reduced by up to 50% by icing build-up on cold focal plane window
  - Correctable with Internal Calibrator
- Bias adjustment of 0.092 W/m^2 sr μm effective 02-Apr-07
  - Only for data acquired since April 1999 (ETM+ era)
  - Recommended users with data add 0.092 to their pre-02-Apr-07 processed radiance level products
  - Pre-1999 era data under evaluation by RIT using Great Lakes buoys
- Radiometric Calibration on Scene-by-Scene Basis using the response to the Internal Calibrator
  - Rescaled to Fixed Radiance Range (LMIN, LMAX)
  - Absolute accuracy ±1%

L5, L7 Delta-L comparison



Summary

- Landsat-7 ETM+ performance stable, except for changes induced by switch to bumper mode
- Landsat-5 TM performance stable through October
  - Restart of imaging expected to require frequent bumper mode calibration
- Landsat-5 TM reflective and thermal band calibrations updated 02 April 2007
  - Thermal band calibration accuracy since 1999 now comparable to ETM+ thermal band